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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/955,388	09/17/2001	Yoo-Sang Hwang	9898-189	9987

7590 09/04/2003

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EXAMINER

MAI, ANH D

ART UNIT PAPER NUMBER

2814

DATE MAILED: 09/04/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/955,388	HWANG ET AL.	
	Examiner	Art Unit	
	Anh D. Mai	2814	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 07 August 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-5 and 9-15 is/are pending in the application.
- 4a) Of the above claim(s) 1-4 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 5 and 9-15 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
 If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 a) ☐ All b) ☐ Some * c) ☐ None of:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
 * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
 a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Status of the Claims

1. Amendment filed has been entered. Claims 7 and 8 have been canceled. Claims 5, 14 and 15 have been amended. Claims 1-5 and 9-15 are pending. Claims 1-4 have been withdrawn.

Claim Rejections - 35 USC § 102

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claims 5, 9 and 12-14 are rejected under 35 U.S.C. 102(b) as being anticipated by Omura (U.S. Patent No. 6,028,362) of record.

With respect to claim 5, Omura teaches a method for manufacturing a semiconductor device as claimed including:

forming an insulating layer (44) having a contact hole (44S) therethrough on a semiconductor substrate (40);

forming a diffusion barrier layer (50) on a surface of insulating layer (44) and on surfaces within the contact hole (44S);

forming a first metal layer (52) on the insulating layer (44) having a contact hole (44S) therethrough, the first metal layer (52) having a void (Q) therein below the top surface of the insulating layer (44);

etching back the first metal layer (52) to the depth of the void (Q) to form a first sub-plug (52s) without the void in a lower portion of the contact hole (44S);

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forming a second metal layer (56) within the contact hole (44S) overlying the first sub-plug (52s) and on the diffusion barrier layer (50), the second metal layer (56) being thick enough to substantially completely fill the contact hole (44S); and

planarizing the second metal layer (56) until the top surface of the diffusion barrier layer (50) on the insulating layer (44) is exposed, thereby forming a second sub-plug (56) that fills an upper portion of the contact hole (44S) on the first sub-plug (52s), the second sub-plug (56) having a substantially flat surface. (See Figs. 19-23A, col. 1-20).

With respect to claim 9, the first sub-plug (52s) of Omura is formed of tungsten (W).

With respect to claim 12, the diffusion barrier layer (50) of Omura is formed of a material as claimed.

With respect to claim 13, the plug formed in the contact hole (44s) contacts the surface of the semiconductor substrate (40).

With respect to claim 14, a void Q has been formed in the first metal layer (52), thus the first metal layer (52) of Omura is a metal layer capable of generating a void in the contact hole (44S).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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3. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Omura '362 as applied to claim 5 above, and further in view of Lee et al. (U.S. Patent No. 6,177,342).

The method of Omura includes forming a second metal layer (56) within the contact hole (44S) overlying the first sub-plug (52s) and on the diffusion barrier layer (50), the second metal layer (56) being thick enough to substantially completely fill the contact hole (44S).

Thus, Omura is shown to teach all the features of the claim with the exception of forming the second metal layer using tungsten.

However Lee teaches tungsten or aluminum can be used interchangeably for the metal layer (42).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to form the second metal layer (56) of Omura using tungsten as taught by Lee because aluminum and tungsten are good conductor and can be used interchangeably.

4. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Omura '362.

The second sub-plug (56) of Omura is formed to a thickness greater than 1000 Å.

Note that the specification contains no disclosure of either the critical nature of the claimed *thickness no greater than 1000 Å of any unexpected results arising therefrom*. Where patentability is aid to based upon particular chosen dimension or upon another variable recited in a claim, the Applicant must show that the chosen dimension are critical. *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

The required thickness of the second metal layer is *thick enough to substantially completely fill the contact hole*. Therefore, it would have been obvious to one having ordinary

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skill in the art at the time of invention to form the second metal layer of Omura to the thickness that enough to substantially completely fill the contact hole.

5. Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Omura '362 as applied to claim 5 above, and further in view of Gates et al. (U.S. Patent No. 6,203,613).

The second metal layer (56) of Omura is formed within the contact hole (44S) overlying the first sub-plug (52s) and on the diffusion barrier layer (50), the second metal layer (56) being thick enough to substantially completely fill the contact hole (44S).

Thus, Omura is shown to teach all the features of the claim with the exception of explicitly forming the second metal layer by atomic layer deposition.

However, Gates teaches atomic layer deposition (ALD) can be used to deposit metal layer () into a contact hole with good step coverage.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to form the second metal layer of Omura by ALD as taught by Gates to form the second metal layer to completely fill the contact hole without a void.

Response to Arguments

6. Applicant's arguments with respect to all claims have been considered but are moot in view of the new ground(s) of rejection since other embodiment is applied.

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Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anh D. Mai whose telephone number is (703) 305-0575. The examiner can normally be reached on 8:30AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on (703) 308-4918. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

A.M
August 26, 2003


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